March 2000

The **Electro-Drive Revolution-**
Why we need it and where its **going**

Notes of a speech given by Mr. Edward Kjaer, Director Electric Transportation Division, Southern California 'Edison, to the Clean Cities Conference. San Diego

Thank you and good morning ladies and gentlemen

What is Electro-drive?

It begins with a fundamental premise-

Any product driven by a combustion technology today . . . . could be powered by **"Electro-** drive" tomorrow

It means basically replacing an engine with a motor and a gas tank with a battery

It encompasses not only the obvious electric car, truck, bus, or train, but also the not so obvious- electric forklifts, golf carts, jet skis, snow mobiles, airport ground support, lawn mowers, leaf blowers, bicycles, scooters, mopeds, ATVS, hybrids, fuel cell vehicles and, what we in the utility business call, "Distributed Generation" or emergency backup power supply

Some of these products may not be prolific today, but they are illustrative of a global environmental revolution that is emerging before us

Why do we need Electro-drive?

Fundamentally for three reasons;

-Energy security

-Emissions reduction

-And Global Warming or C02 reduction "

Let's take these one at a time-

Energy Security- **50%** of the world's petroleum supplies are consumed to satisfy transportation needs **today**

In 1974 when the oil crisis hit, the U.S. was **45%** dependent on imported oil, today we are 60°/0 dependent

In California, we are the world's third-largest consumer of gasoline- some 14 billion gallons annually. And as has been painfully demonstrated recently, such dependence on foreign oil can significantly impact our regional economy, when supply is curtailed or prices inflate

December 1999, a barrel of oil cost around $12.00. Recently it has been over $30.00 . . . . U.S. gasoline prices, at the pump, have rocketed from $1-1.25 to almost $2.00 a gallon in just 4 months. Now admittedly Americans should not complain. We still have the cheapest gasoline in the western world . . .. But try telling that to those of us who love to drive!

Petroleum, by all accounts, is not an infinite resource. Pundits predict a reduction in world supply beginning within the next 50 years

As oil becomes harder and harder to recover and refine, prices will inevitably increase, thus impacting consumption

Exhaustion may take many years . . . . but it will **happen**

The second issue is ***Emissions*** reduction- Transportation contributes 75% of the world's emission pollutants with stationary sources delivering the rest

In California our almost 30 million vehicles on the roads account for over 70 % of our urban smog

In fact, 90% of all Californians live in areas that do not meet Federal of State standards for healthy air

Air pollution contributes to lung and other types of cancer. Lung disease is the third leading cause of death in the U.S., claiming close to 350,000 lives each year. Over the past decade, the death rate for lung disease has risen faster than that of any other among the top five causes of death

Significant early efforts to reduce air pollution targeted large "stationary sources" of emissions such as factories and power plants. At the same time, Americans were buying more cars, often to accommodate two wage-earners, and were driving farther in their increasingly suburban lifestyles. As a result, the portion of pollution coming from mobile sources" has grown dramatically. But more on this later

The third issue is ***Global Warming or CO2 reduction***- Over the last twenty years, demand for passenger and freight transport has doubled and this sector alone represented 30°/0 of total world C02 emissions

Our nation's President recently said, and I quote-
"The greatest environmental challenge of the new century is globs! warming..

If we fail to reduce the emission of greenhouse gases, deadly heat waves and droughts will become more frequent, coastal areas will flood, and economies will be disrupted. That is going to happen, unless we act . . ...”

Global Warming is at best misunderstood today. It is emerging as the 21 ^{S}'. century's most significant environmental issue. I believe global societies can not take this issue lightly in the future

Now I suggested there were three important reasons why we need **Electro-drive** **today**

But there is also one critical reason why we need **electro-drive** tomorrow- ***Global population growth***

Our global population is anticipated to literally double from about 6 billion today to around 12 billion by 2050

This increase will largely happen in developing countries, concurrent with a general population concentration in urban centers

Today, there are 5 giant cities of more than 15 million inhabitants, in 20 years there will be 10 more, all located in Asia and Latin America

Because transportation is **99%** dependent on one energy source- petroleum-it is the major nexus of our current and future problems with population growth, energy dependency, air quality, and climate change

Of **all** the transportation technologies envisioned for the next 50 years, to meet growing population and urbanization, successfully commercializing **electro-drive** products promises to deliver& **single** most effective environmental **improvement** to our global societies

But haven 't U.S. emissions from cars been reduced over the last decade?

True the internal combustion engine is upwards of 90°A cleaner than it was 10 years ago, and that's good, but we are simply buying more cars than ever before

Compounding this problem, as I mentioned previously, people in the U.S. are actually traveling further than they did 10 years ago

In a recent national study of 80,000 homes,

- ⇒ 92°/0 of respondents said they preferred to take the car rather than **fly** between 300 and 500 miles
- ⇒ 76°/0 still preferred the car when traveling between 500 and 1,000 miles

- ⇒ And a staggering 50°A **still** preferred the car over the plane when traveling between 1,000 and 2,000 miles
- ⇒ So the net effect of more cars and longer travel distances, more than outweighs the fact that combustion cars are getting cleaner

Others will argue that fuel economy is improving

True vehicle technology has made tremendous fuel efficiency gains, however in the U. S., the biggest beneficiary is small cars!

Unfortunately American car buyers tend to love big cars, especially big Sport Utility Vehicles or **SUVs.** In fact 1999 model year was the largest one year gain for SUVS ever

These types of vehicles are actually hurting the U.S. average fuel economy figures. For instance in 1986, trucks accounted for 28% of the U.S. automobile market with cars making up the other 72°/0. Today trucks have grown to almost 50°/0 of the market

According to our Environmental Protection Agency, overall U.S. fuel economy (mpg) slumped to its lowest level since 1980. In fact 1999 was the highest average fuel **consumption** in 19 years!

Still others are arguing that Electro-drive simply pushes the emissions issue "upstream" to the source of electricity production

This is generally not true. For instance, power plants in California produce much less pollution per unit of energy than gasoline car engines because they use cleaner fuels such as natural gas. And about 30°/0 of California's plants are hydroelectric, geothermal, wind or solar and produce no air pollution at all

California power plants also employ the most sophisticated emissions control equipment in the world

Even when upstream emissions are included, electric vehicles **(EVs)** produce& than 1 **%** of the emissions of the cleanest gasoline vehicles available today. By eliminating gasoline, oil and many of the lubricants required for internal combustion engines, EVS also reduce the threat of oil and gas spills, water pollution from roadway runoff, and hazardous waste disposal

In the U. S., if we are to effectively meet the transportation needs of an ever increasing urbanized population, and meet them **cleanly,** we need to fundamentally change the way we think about mobility

This means a cultural shift in the way we view the automobile, and its role as part of a new fully integrated "inter-modal" transportation system-

Today in the **US,** our transportation **system is** the automobile! We;

⇒ lack effective public transportation alternatives
⇒ have weak connections between urban centers, airports, train stations
⇒ have extensive freeway systems
⇒ have relatively cheap gasoline
⇒ have an emotional connection with the automobile- it's an image statement- there's a perception - bigger is better

Tomorrow our transportation system must be "clean solution" based comprising of integrated components.

We need;

⇒ high speed rail for inter-urban rapid travel
⇒ connected to inner urban mass transit
⇒ connected to major commuting hubs- airports, train stations, bus stations, city centers
⇒ connected to suburban centers
⇒ connected to residential locations

All these "solution" based technologies should have one thing in common- "The Power of **Electro-drive"**

This revolution, out of necessity, has begun all over the world in countries such as France, Italy, Japan, China, Hong Kong, India, the U.S. and now in Taiwan- with the advent of a zero emission scooter mandate... But this should just be the **beginning-**

In the U.S., the **electro-drive** revolution covers many different products and markets such as Marine, on-highway (freeway), off road and on road. I'd like to take a few minutes and discuss some examples;

Marine

⇒ jet skis - noise and particulate pollution
⇒ recreational boats - **Duffy** boats and Newport harbor

On highway

⇒ **buses/** school buses)
⇒ **cars/trucks**) *pure EV/grid and non-grid*
⇒ **Delivery** vehicles) *connected hybrids*

Off road

⇒ High speed rail- California HSR project
⇒ commuter rail
⇒ light duty utility vehicles

⇒ golf carts- California mandate
⇒ NEVS
⇒ Airport Ground Support- possibility of mandate
⇒ Forklifts- 30-500/0 market share

On road .

⇒ Trolley buses
⇒ commuter vehicles- Station car concept Ford Think Group
⇒ Parking enforcement
⇒ Postal Delivery vehicles- USPS project

Section Summary-
I've talked about what **Electro-drive** is and why we need it - energy dependency, emissions, global warming and population growth

I've addressed some of the popular misconceptions (***emissions, fuel*** economy)

I've discussed the need for fully integrated inter-modal transportation systems in the future

And we've covered how broad the revolution is- not just the automobile but fundamentally any product built on combustion technology

Now I would like to discuss why the electric utilities around the world should be the "Powerhouses" of the **Electro-drive** revolution

To best demonstrate this, let me explain ***why Southern California Edison is a leading supporter of Electro-drive***

Today, Southern California Edison or SCE serves around 11 million customers in 800 communities in our service territory

As the 21'*. **Century** fuel **provider** for these emerging **electro-drive** technologies, we owe it to our customers to clearly understand the impacts of product proliferation on our systems and to develop knowledge, processes, procedures, and technology, to minimize future utility and customer side infrastructure costs.
We need to;

⇒ educate and help customers to integrate these new technologies into their businesses and/or lives
⇒ help infrastructure ***(chargers, connectors, etc.)*** manufacturers develop safe, reliable, **efficient** interfaces

⇒ evaluate long term technologies ***(High Speed Rail, Fuel Cells)*** to determine future system impacts
⇒ comply with U.S. Energy policy Act **(EPAct)** requirements for utilities to buy EVS and avoid significant non-compliance penalties
⇒ help proliferate these technologies to maintain economic development in the state and help meet clean air standards, thus avoiding federal fiscal penalties

Additionally, we seek to deploy these products in our business operations, to generate data and learning that we can then apply to our customers through direct assistance or education programs

The best example of deploying the technology, and the one we are most proud of, is SCE'S Electric Vehicle fleet **program-**

It's a ***working*** fleet . . . . To date;
⇒ we have over 320 vehicles, with over 3 million miles of "real world" EV operation
⇒ we have managed to displace 110,000 gallons of gasoline
⇒ we have avoided 650,000 pounds of emissions
⇒ and we have avoided over 1,400,000 pounds of C02 or green house gases

And now annually **SCE's** EV fleet;
⇒ does over 1.5 million EV miles
⇒ saves 62,000 gallons of gas
⇒ reduces emissions by almost 30,000 pounds
⇒ and avoids over 1,000,000 pounds of C02

To date almost 12°A of SCE'S total Light Duty Fleet is electric. Of Edison's 45 fleet operator territories, within our service area, the penetration of EVS to **ICs** ranges from as low as 4°A to as high as 600A!

Additionally, SCE was instrumental in helping John Wayne and Ontario airports to install electric infrastructure to support new clean ground support equipment. Airport GSE is a rapidly growing market for **electro-drive** around the country and is seen as a meaningful strategy to addressing heavy emissions from baggage carriers, tugs and belt loaders as well as aircraft APUs

With the learning from our John Wayne and Ontario experiences, SCE is now actively pursuing other airport customers wishing to **electrify** their GSE

Another **electro-drive** market that SCE is actively participating in is forklifts. Somewhere between 30 and 50% of the forklift market today is electric. Through the Carl Moyer program, SCE has helped customers in our service territory to

convert over 200 combustion forklifts to electric. Other incentive programs are under development to continue this momentum

Products in the future that SCE believes. will come to commercialization include; buses both pure electric and hybrid; urban or station car EVS such as the Think Group's Think City; and stationary battery applications including **telecom** emergency power back up

More and more utilities around the world are recognizing the need to research, evaluate, demonstrate, and support **electro-drive,** not only from our own systems perspective, but also as a customer support issue. I believe **electro-drive** is inevitable, either through **regulation/legislation** or market forces. Utilities, as 2 **1st.** century fuel providers, need to be committed, informed and leading the way

I'd like to take a few moments now and talk about the EV car program in California, and the future of **electro-drive** in the automobile marketplace

The demonstration program over the last few years, I believe, has been a resounding **success;**

- ⇒ Each auto maker fielded viable, credible products that for the most part worked flawlessly
- ⇒ Two auto makers hit their volume commitments in half the time allotted by CARB
- ⇒ Every auto maker has garnered priceless technical and customer information vital to future EV, hybrid and fuel cell products
- ⇒ Battery companies have developed advanced batteries rapidly and better understand their performance, durability and reliability
- ⇒ Every utility understands infrastructure needs and demands not just from a systems perspective but from a customer perspective
- ⇒ Policy makers better understand the need for incentives and programs that support early adoption of new technology
- ⇒ And peripheral industries including commercial, industrial and recreational products are beginning to enjoy the technology migration and the future advantages of **electro-drive**

While the results of the demonstration program are significant, they have been lost on the press and the marketplace, who continue to confuse demonstration with commercialization

Let me be clear- EVS have not been launched in California. Some 45 EV dealers out of 5,000 in the state, does not constitute a retail launch. Lease only does not reflect real market options ([ease, ***purchase, finance).*** A lack of competitive choice ***(sportscar to sportscar, sedan to sedan, SUV to SUV) does*** not reflect real market dynamics. A wholesale lack of category advertising (GM, ***Honda, Nissan, Ford, Toyota, Daimler/Chrysler)*** does "not reflect traditional ICE marketing. And stakeholders claiming a lack of consumer demand are confused with a lack of consumer awareness

EV automobiles, as the standard bearer for **electro-drive,** should be given a fair market hearing. But we should not consider the pure EV as a replacement for the ICE industry. Rather EVS should be application specific and part of a new integrated transportation system

Possible solution based applications could be urban or station cars replacing short distance trips and commutes where, **all** too often, fuel hungry SUVS hog the road. Best examples of these types of vehicles would be the Think group's "City" vehicle, Nissan's Hyper mini, and Toyota's E-Corn

The debate on "full size" EVS rages on. Some industry players suggest a dual mode (freeway/city) EV is just too cost prohibitive relative to battery size and resulting cost. I would suggest we look more aggressively at this issue

Battery cost is coming down. Five years ago advanced batteries cost about $3000 a kWh. Today they cost about **$1000** a kWh. By 2003 industry projects costs around $350-$400 a kWh. All this with no volume

I believe GM has demonstrated that the combination of **efficient** aerodynamics, effective weight reduction and interestingly, High Capacity Lead Acid batteries ***(upwards of 50% less cost than NiMH)*** could make full size EVS more business viable. **I** think we should all revisit the issue of Lead Acid in conjunction with aerodynamics and weight reduction

Additionally more work needs to be done by utilities and government on the issue of stationary battery applications. Today Lead Acid batteries are used in stationary applications all over the world. In fact here in the U. S., the **Telecom** battery market is $600 million. By 2003, it is projected to grow to $1 billion. Used advanced EV batteries with upwards of 80% capacity remaining could offer attractive characteristics to this huge market ***(lighter weight, increased density, increased life, less maintenance).*** Already today several utilities are leading the charge to address this issue. This could potentially be the single biggest element to reduce battery cost

I also believe the EV industry is laboring under the misconception that more range is better. Or more accurately, the same range as an **IC** equivalent is preferable.

Range studies are generally based on respondents who have never "lived" with an EV. With the advent of "fast" public charging, the added benefit of workplace charging, and nightly residential charging, vehicle ranges in the area of 80-100 miles should be more than adequate. However significant consumer education will be needed to overcome perception problems in this area

We should all aggressively welcome the advent of hybrids and fuel cells as well. These zero or potentially near zero emission technologies are all part of the electro-drive family. Sure grid-connection is preferable (fess ***emissions, lower fuel costs, less dependency on petroleum)*** but frankly any technology that **significantly** reduces fuel consumption, emissions and C02 should be in the transportation mix. I strongly believe the integrated transportation system of the near future has a concurrent place for pure EV, hybrids and fuel cells. Each application specific, each contributing to a cumulative environmental improvement, and each business viable in the marketplace.

Ladies and Gentlemen...
The **Electro-drive** revolution is upon us. While today it is but a whisper, I believe it will grow to a "shout" in the not too distant future

It **is** a viable alternative to the internal combustion engine. It is the only technology we know **of today** that adequately addresses transportation emissions and Global Warming

It should be viewed not in terms of individual products, but rather as a fundamental shift in how societies live, **work,** and play. How they commute and transport goods. How they plan for urban growth. And most importantly, how they interact with their environment

I would like to conclude with the words of the French philosopher Antoine de Saint Exupery.. . . . "We ***do not inherit the earth from our parents, we borrow it from our children"***

Thank you